Re-Design of Motor-Bike Seat using Three Dimensional Reverse Engineering

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DECLARATION

We hereby declare that this thesis is our own work and effort. Throughout this documentation wherever contributions of others are involved, every endeavour was made to acknowledge this clearly with due reference to literature. This work is being submitted for meeting the partial fulfilment for the degree of Bachelor of Technology in Industrial Design at **National Institute of Technology, Rourkela** for the academic session **2011 – 2015.**

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Certificate of Approval

This is to certify that the thesis entitled RE-DESIGN OF MOTOR-BIKE SEAT USING THREE DIMENSIONAL REVERSE ENGINEERING submitted by Anubhav Gupta & Abhinav Kumar has been carried out under my supervision in partial fulfilment of the requirements for the Degree of Bachelor of Technology in Industrial Design at National Institute of Technology, Rourkela, and this work has not been submitted elsewhere before for any other academic degree/diploma.

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ABSTRACT

In today's competitive world, automobile seat design has been considered as an important criterion to satisfy the comfort expectation of the population. This present dissertation highlights the comparative study for the bike seats available in the market and also proposed the novel seat design for better comfort. Statistical tool has been utilized to analysis the number of bikes reviewed for drivers' seat features. The proposed design has been attained using the 3-D Reverse Engineering procedure on the selected car seat models. From the results it has been concluded that modified bike seat design is superior in terms of form, shape, seat features, usability and comfort.

CONTENT

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1. INTRODUCTION

Today's globalized business sector rivalries among the different auto commercial ventures drives the motorbike makers to plan their items particular to customers' decisions and fulfillment. During the design and development of bike seat, driver’s posture is the most important factor to be considered among others the user comfort has to be maximized. The human impression of short and long haul solace is immeasurably subject to the seat plan alongside the position of controls on the handle and side of the motorbike. The way of vibration persisted by the drivers and presence of poor workstation design likewise brings about poor carriage while driving that prompt physiological side effects of distress and agony. With development in innovation the needs and desires of the clients increments in appreciation of picking up a more agreeable and tastefully satisfying item.

The solace capacity and wellbeing of a seat is extremely imperative to a bicycle's outline and creation. Drivers' solace is just as essential as the utilitarian and stylish parts of autos since it is given more inclination by the clients for an agreeable commute. As the situated carriage of a person opens him to a mixture of musculoskeletal inconveniences, sitting solace is of top need that requires ergonomic mediations in the early outlining stages.

In this part the need to take up this work alongside foundation is talked about. It additionally displays a survey of accessible pertinent writing. Destinations of the present work alongside system received to achieve the objectives have been examined here.

1.1 Background of The Work

Looking around the various discomforts in the current motorcycle seat designs, we thought to do the survey of some existing bike seats to get the best among them. We choose set of people for survey which were the college students who are generally having the riding experience of 4-5 years. So we took 3 bikes of 150-160 cc segment (Yamaha R15, Bajaj Pulsar, and TVS Apache RTR) and surveyed 15 students of our college for all the three bikes each.

1.2 Problem Statement

There are large number of motorcycles present in the market with different seat designs now-a-days. But the main problem is that no seat is perfect, different seats are having some parts of them which are more comfortable among the other motorbikes. The aim is to study the different bike seats present and do the subjective analysis to design the new seat which would be having selected features from different bike seats to provide a new comfortable design. Subjective analysis is done using the data from the survey conducted among the selected group of population. The selected seats would then be scanned using 3-D Reverse Engineering and the new seat designed using the result of statistical analysis and captured 3-D data would be justified by a survey conducted among the same group of population

The objectives of this task can be determined as follows:

- To conduct a survey of different bike seats of a particular group of population.
- To collect the data and organising it in a better way to extract the required information.
- To do the statistical analysis of the surveyed data using statistical tool.
- 3-D scanning of top seats using reverse engineering and designing a new seat.
- Surveying to justify the new seat designed.

1.3 Literature Review

Significant endeavors have been made in the past via scientists to give the creators of bicycle seats with powerful rules towards giving the car business more agreeable seats. The ability to comprehend the solace level gave by the car seat requires a top to bottom comprehension of biomechanics of situated stance, seat geometry impact on people, seat properties and the vehicle environment on saw solace.

Seat comfort is a complex phenomenon (Looze et al, 2003). Looze et al. (2003) made an analysis of the scientific literature concerning the relationship between sitting comfort and discomfort and objective measures. He found pressure distribution was the objective measure that provided absolute transparency in its association with the subjective ratings. Looze et al (2003) focused on

comfort effects and Nordin (2004) on the effects of sitting and back complaints. Lueder (2004) uses the literature to show the importance of movement while seated and Zenk (2008) made a literary review of comfort and sitting while driving. Factors influencing the subjective ratings also include skin perception, muscular activity, posture, joint angle interface, pressure, stiffness and suspension of the seat cushion and backrest. Posture variation and frequencies of posture changes are also measured. Mergl (2006) states that the seat should reduce postural stress and optimize muscular tension. Porter et al. (2003) explained the importance of pressure distribution to avoid high pressure areas. For instance, the tissues around the ischial tuberosities are subjected to extremely high pressure while sitting that can result in reduction of blood circulation through the capillaries. In such cases it is necessary to realign body position, else then the symptoms of aches, pain, discomfort and numbness start surfacing up. Nordin (2004) also showed that sitting in restricted postures as well as sitting in combination with vibration is a risk factor. This means that for bike seats the risk is there. Ariens (2001) showed that unsupported static postures also increase the chance of neck pain.

Bower-Carnahan et al directed overview on inclination of overwhelming truck drivers with respect to seat outline. The general appraisals for driver solace and customizable suspension damping included them as the most imperative highlights. This study additionally indicated the areas of physical inconvenience through an uneasiness point plot. The five ranges specifically that were very identified with seating inconvenience:

- Discomfort in upper neck and back; created principally because of strain of driving throughout the day and because of the necessity of keep up the head in legitimate position for broadened spans.
- Discomfort in shoulders; starting principally because of dishonorable situating of seat as for controlling wheel and directing wheel edge.
- Discomfort in lower back because of deficient and dishonorable lumbar backing.
- Discomfort in rear end ascribed to the uneven weight connected at the human-seat contact locale.
- Discomfort in back area of thighs simply over the knee district created because of disgraceful weight.

Despite the fact that the workstation and geometry of truck and auto are diverse, the concerns relating to the seat solace and feeling of inconvenience can be by and large tended to.

1.4 Methodology

The approach adopted to accomplish the present work is described as below:

- Select the bikes of same segment for conducting survey.
- Checking on and arranging the parameters or highlights in charge of the comfort discernment on the buyers
- Selecting the group of population for survey.
- Surveying of the users for rating of various attributes for comfort and discomfort of users.
- Collection of Data and organizing it using a statistical workbench. This gives us the seats with best attributes and features.
- Best bike seat models are scanned using the coordinate measuring machine available to obtain CAD model and 3-D data.
- New seat is designed using the statistical data from the survey with best features and attributes of scanned seats. Customer feedback and suggestions are also incorporated and modifications are done.
- Survey is done to justify the new designed seat.

2. COMFORT ASSESSMENT OF BIKE SEAT

2.1 Subjective Assessment

In this assessment process, a group of people were chosen to give the survey. Questionnaire was prepared to explore and establish the various aspects of the bike seat and the comfortability of the user. Participants (n=15) aged in the range of 22-30 having driving experience not less than 6 months were interviewed. Three main bikes of 150 cc – 160 cc range were surveyed .Ratings of each was determined by each of the participants. Question was based on how the bike seat affect the comfort and discomfort of the whole body of the user. It was mainly divided into two parts:

- Assessment of pain perception in body parts
- Assessment of seat features

The seat features and afflicted areas of the body that endure the maximum pain are defined as follows:

Seat Features Considered for Assessment	**Body Parts Pain Perception Assessment**
Distance from handles	Buttock
Height of seat	Lower back
Cushion softness	Upper leg
Shape of seat	Shoulder
Adjustment Features	Neck
	Arms
	Head
	Limb joints

Fig 2.1 Features and afflicted areas of the human body

SURVEY FOR BIKE SEAT DESIGN

Personal Detail:

NAME:-_____ AGE: - _____

GENDER:-_____ HEIGHT:-_____

WEIGHT:-_____ Ph. No.:-_____

EMAIL ID:-_____

For how many years you are driving? _____

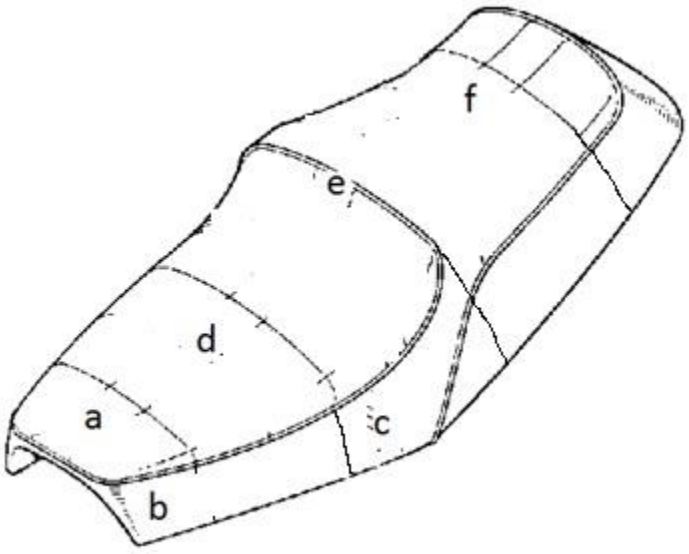
Rate the below question from 1 to 5 for this bike:

1	2	3	4	5
Very discomfort	Discomfort	Neutral	Comfort	Very comfort

	1	**2**	**3**	**4**	**5**
1. Is length of the seat is comfortable?	__	__	__	__	__
2. Is width of the seat is comfortable?	__	__	__	__	__
3. Is height of the seat is comfortable?	__	__	__	__	__
4. Is curvature of the seat is comfortable?	__	__	__	__	__
5. Comfort level of your backbone?	__	__	__	__	__
6. Comfort level of your hip?	__	__	__	__	__
7. Comfort level of your shoulder?	__	__	__	__	__
8. Comfort level of your elbow?	__	__	__	__	__
9. Comfort level of your neck?	__	__	__	__	__
10. Comfort level of your thigh?	__	__	__	__	__

11. Comfort level of your knee? __ __ __ __ __

Considering roughly at different parts of the seat as shown below, rate the comfort zone of various parts –



	1	2	3	4	5
12. Comfort level of part 'a' ?	__	__	__	__	__
13. Comfort level of part 'b' ?	__	__	__	__	__
14. Comfort level of part 'c' ?	__	__	__	__	__
15. Comfort level of part 'd' ?	__	__	__	__	__
16. Comfort level of part 'e' ?	__	__	__	__	__
17. Comfort level of part 'f' ?	__	__	__	__	__

Any other solution of the betterment of the seat? (If any)

Thank you for precious time.

2.1.1 Data Collection

The survey papers from the individuals were assembled and collaborated into an Excel sheet. The evaluations for both, seat highlights and pain fixation was registered and result rating for each model for each part was recorded.

2.2 Statistical Analysis for Comfort Assessment

The questionnaire was drafted into excel sheet and the analysis of the data was done by the IBM – SPSS software.

Firstly the data of the various comfort level of the body parts were inputted into the SPSS software. The criteria is the various factors that affect the comfort level of the user such as length width height curvature etc. of bike seat. All criteria are listed in the fig 2.3. The datasheet is as shown in the figure 2.2.

	criteria	bike	score	var	var
1	1.00	1.00	4.33		
2	1.00	2.00	3.93		
3	1.00	3.00	3.80		
4	2.00	1.00	4.06		
5	2.00	2.00	3.87		
6	2.00	3.00	3.66		
7	3.00	1.00	4.33		
8	3.00	2.00	3.60		
9	3.00	3.00	4.20		
10	4.00	1.00	3.86		
11	4.00	2.00	3.93		
12	4.00	3.00	3.66		
13	5.00	1.00	3.73		
14	5.00	2.00	3.66		
15	5.00	3.00	3.53		
16	6.00	1.00	4.20		
17	6.00	2.00	4.46		
18	6.00	3.00	4.13		
19	7.00	1.00	4.26		
20	7.00	2.00	3.46		
21	7.00	3.00	4.13		
22	8.00	1.00	4.20		
23	8.00	2.00	3.66		
24	8.00	3.00	4.06		
25	9.00	1.00	3.66		
26	9.00	2.00	4.26		
27	9.00	3.00	3.46		
28	10.00	1.00	4.26		
29	10.00	2.00	4.26		
30	10.00	3.00	3.60		
31	11.00	1.00	4.00		
32	11.00	2.00	4.06		

Data View | Variable View

Fig 2.2 Ratings of comfort levels of body parts.

The corresponding data was used to derive which seat has the best design for the comfortability of various body parts. The chart is as shown in the figure 2.3.The chart clearly shows that overall comfort rating of Pulsar seat was highest. Second in the rank was Yamaha R15, as shown in the figure 2.4. .But some of the body parts has more comfort in R15 such as hip, neck, knee.

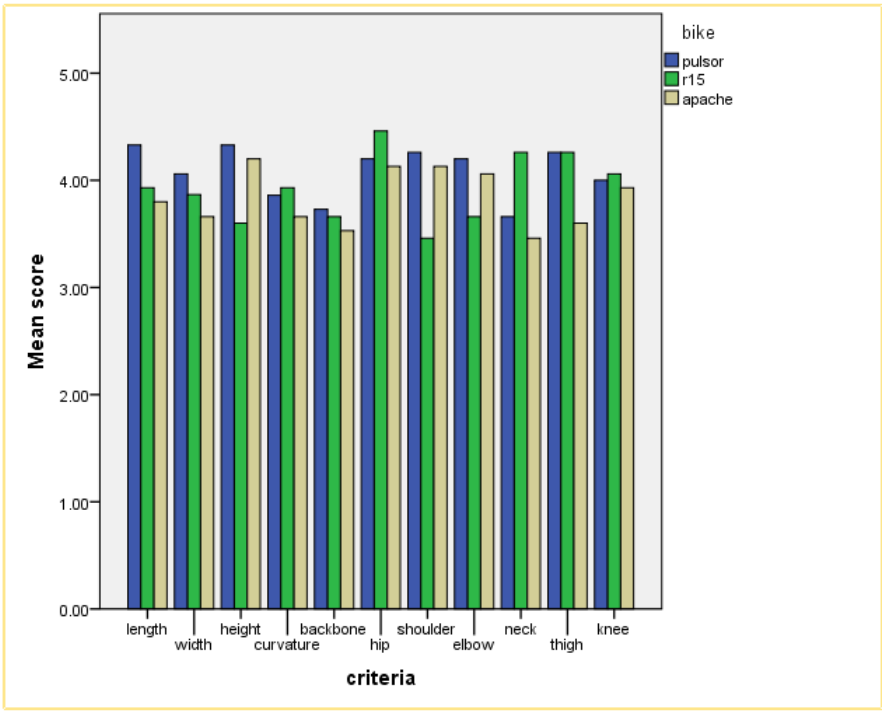


Fig 2.3 Bar chart representing which bike is best for the body parts

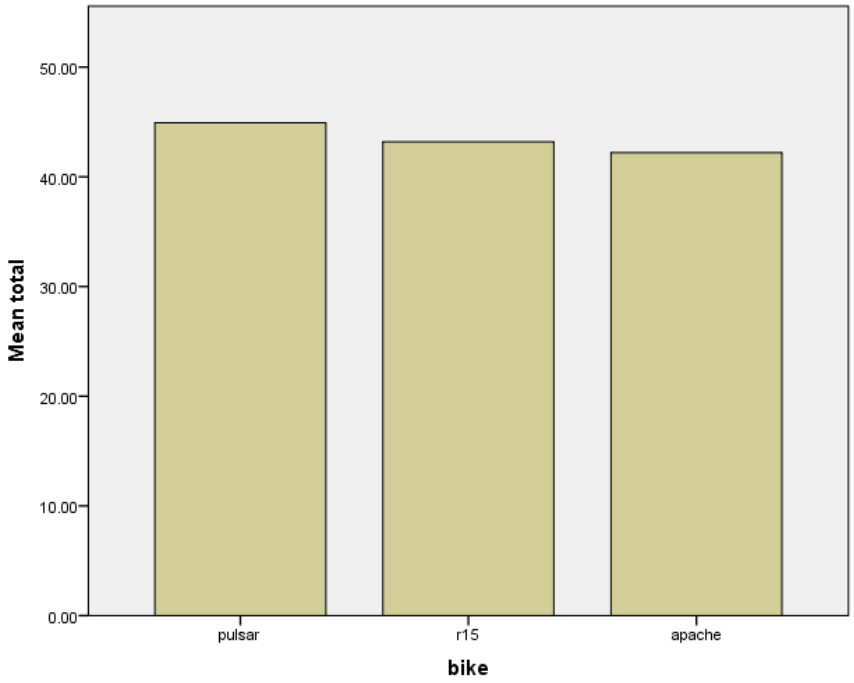


Fig 2.4 Overall rating for the comfort of body parts of the three bikes.

The seat was divided into various small parts so that the user can easily recognise the parts and give its rating. This rating was able to decide which part of the seat is best in which bike .And overall which bike has more rating. The data is shown in the figure 2.5. The result is shown in the figure 2.6.

	seat_part	bike	score	var
1	1.00	1.00	4.66	
2	1.00	2.00	3.53	
3	1.00	3.00	3.13	
4	2.00	1.00	3.73	
5	2.00	2.00	3.93	
6	2.00	3.00	2.87	
7	3.00	1.00	3.53	
8	3.00	2.00	3.73	
9	3.00	3.00	3.00	
10	4.00	1.00	4.33	
11	4.00	2.00	4.33	
12	4.00	3.00	4.00	
13	5.00	1.00	4.00	
14	5.00	2.00	4.06	
15	5.00	3.00	4.00	
16	6.00	1.00	3.93	
17	6.00	2.00	4.00	
18	6.00	3.00	3.53	
19	.	.	.	

Fig 2.5 Data for the ratings of the various parts of seats.

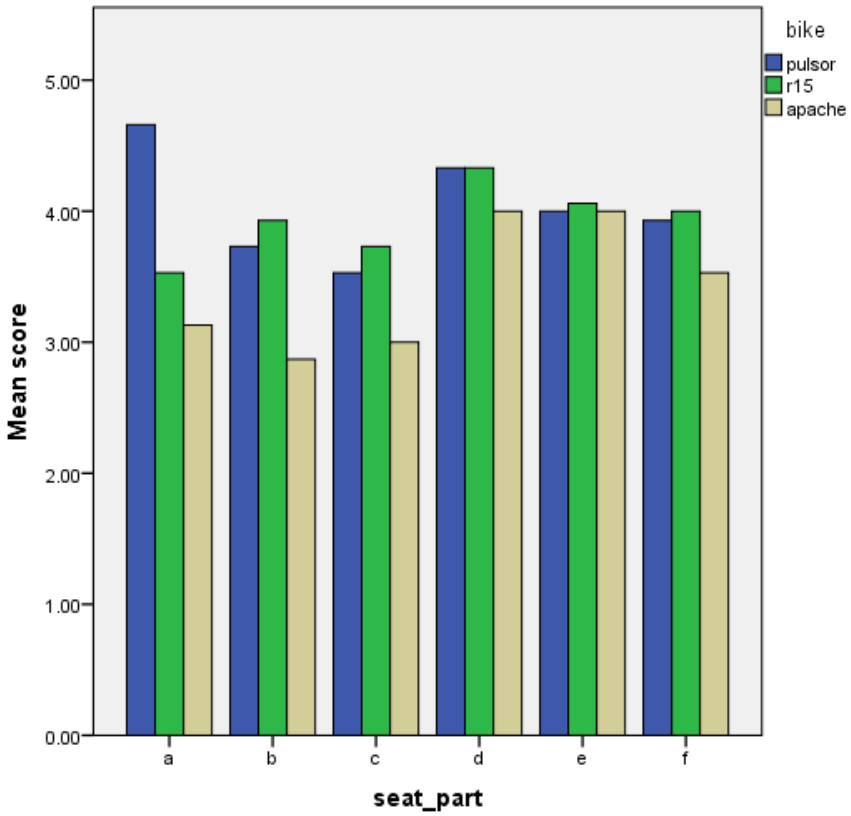


Fig 2.6 Chart for the comfort ratings of the seat parts.

The chart shown above suggest that no bike has all parts of seat as best but each bike has some best part of seat.

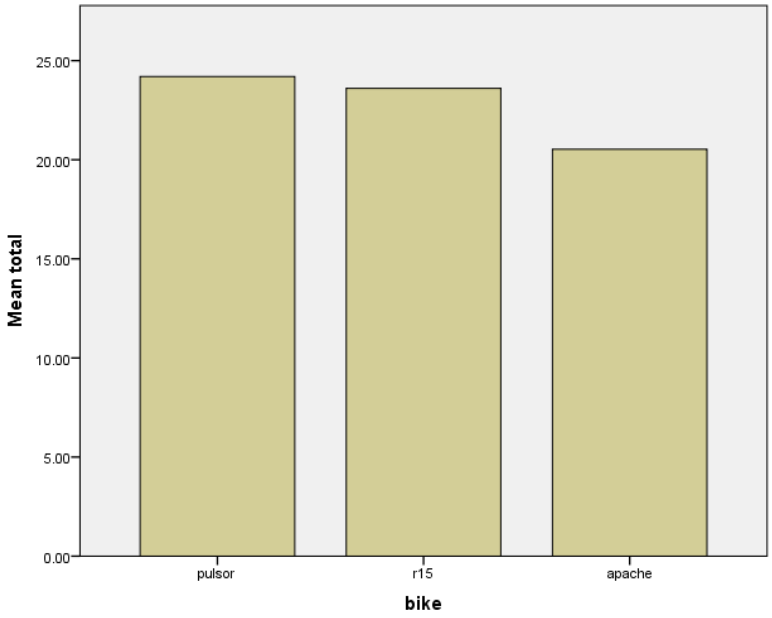


Figure 2.7 Overall rating for the seat of the bike combined

3. CAPTURING THREE DIMENSIONAL DIGITIZED DATA OF BIKE SEATS

3.1 Reverse Engineering

Reverse Engineering is one of the developing innovation, which covers a lot of activities. Reverse Engineering is an unmistakable methodology of accomplish a geometric Computer-Aided Design (CAD) model extracted from 3-D points which are accumulated utilizing examining or digitizing existing parts and items. The procedure of digitally catching the physical substances of a module, alluded to as reverse engineering (RE), is regularly characterized via scientists with respect to their particular undertaking (Motavalli & Shamsaasef, 1996). Abella et al. (1994) described RE as the fundamental hypothesis of fabricating a part built on a primary or physical model devoid of the use of an engineering drawing. Yau et al. (1993) has described RE, as the method of recovering new geometry from a manufactured part by digitizing and altering an existing CAD model.

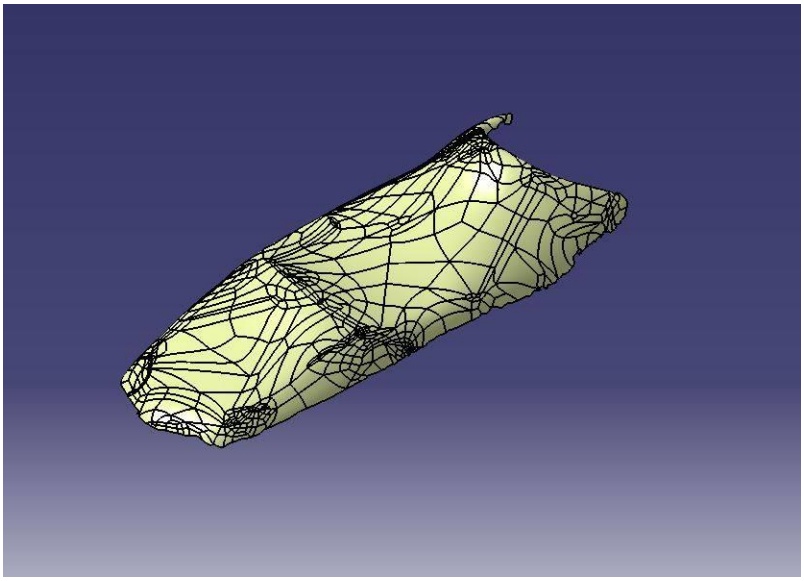
3.2 3D Scanning of Bike Seat

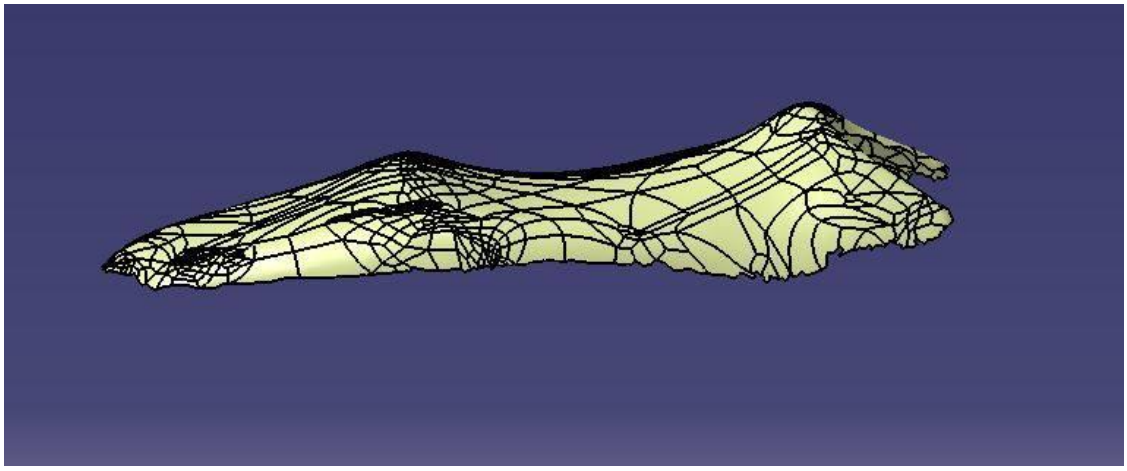
3.2.1 Data capturing

There are numerous systems for getting shape information, contact techniques where the surface is touched by method for mechanical tests toward the end of an automated arm like CMM while in non-contact strategy, light, stable or attractive fields are utilized to collaborate with the surface or the volume of the article. Contingent upon the extent of the part examined, contact systems can be protracted on the grounds that every point is delivered in a steady progression at the tip of the test.

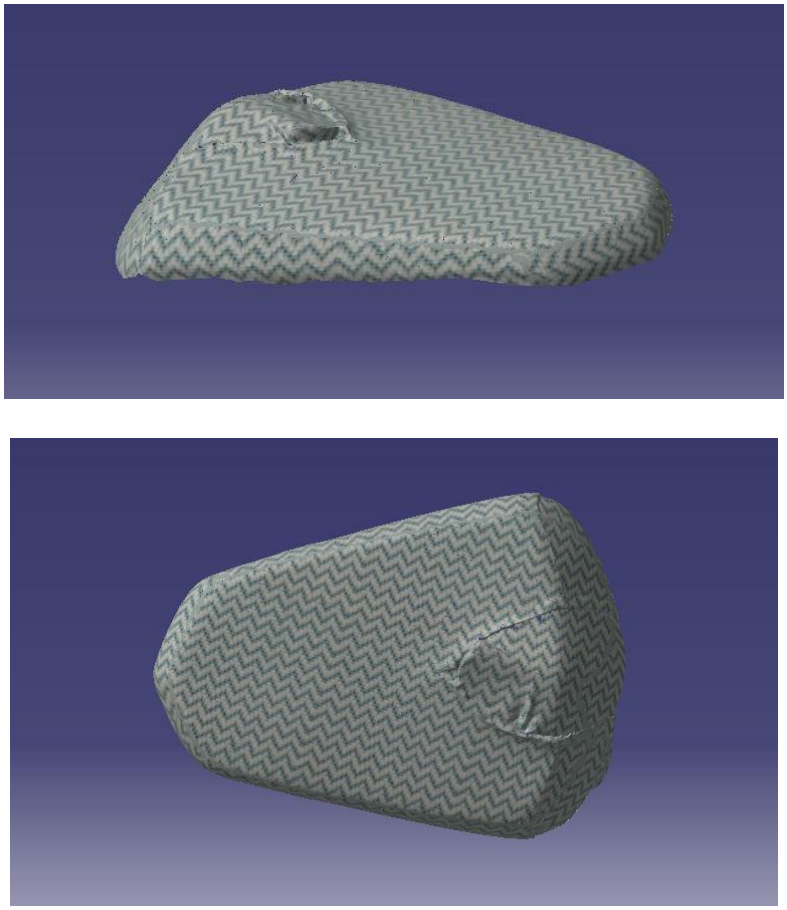
Optical strategies for shape social occasion are the most across the board and have moderately quick achievement rates. Noncontact gadgets use light inside the information catch process. There are five noteworthy classes of optical routines: triangulation, running, interferometry, organized lighting and picture examination. In Laser Triangulation strategy the scanners utilize either a laser line or only one laser point to output over an item. A sensor gets a handle on the

laser light that is imitated off the item utilizing trigonometric triangulation; the framework then break down the separation from the article to the scanner. Running is a technique where the separation is detected by time-of-flight of light bars; Interferometry decides the separation as far as wavelengths by means of obstruction example. Organized Lighting makes utilization of anticipating examples of light upon a plane of the article and catches a picture of the weighty example as reflected by the surface. Information can be accomplished utilizing sound-related techniques which involves sound (SONAR) and attractive field.





Yamaha R15



Bajaj Pulsar

Fig 3.1 Captured Data of Bike Seat using FARO Arm

3.2.2 Preprocessing

This stage incorporate importing the point cloud information to a point cloud information overseeing programming, enlisting, evacuation of the clamor and information lessening steps.

In the event of complex shape, the scanner can't catch the complete surface information from a solitary filtered course. By changing the article introduction, the item must be checked numerous times from distinctive bearings. A part of point cloud information is acquired each time the article is checked. A system to consolidate all divided point cloud information into a solitary direction framework is called enlistment.

Keeping in mind the end goal to make a smooth and precise surface model, commotion free point cloud information is vital. Information Reduction is a methodology to diminish the quantity of point mists while keeping the sharpness of the part.

3.2.3 Segmentation and Surface Fitting

The methodology of changing over point mists to freestyle surfaces can be isolated into two: bended based demonstrating and polygon based displaying. In the bended based demonstrating, the point mists are revised into a normal example (arrangement of cross segments). These are further subdivided into less complex states of point sets, after which surface fitting is performed. Cleaning capacity is utilized to fit bends to an approximated NURBS (Non Uniform Rational B-Spline) surface model which are consolidated to make a legitimate CAD model.

3.2.4 CAD Model Reconstruction

The formation of CAD counterfeit up from point information is the most complex activity inside RE on the grounds that viable surface fitting calculations are vital to deliver surfaces that precisely symbolize the three-dimensional information delineated by the point cloud information. Extension in the utilization of quick prototyping and tooling advances have served to abbreviate detectably the time taken to make physical outlines from CAD models. The completely parametric last 3D CAD model could then be utilized by the client for innumerable purposes including outlining shape and tooling, overhauling of the seat, or extra building examination.

3.3 Measuring Devices Used for Bike Seat Scanning

The Data Acquisition machine utilized as a part of our undertaking is of non-contact sort which utilizes optical Triangulation strategy to sweep the surface. The Laser Scanner comprises of the Laser Probe which emanates a Laser Beam to the part and the CCD (Charged Coupled Device) cams then catch 2D picture of the anticipated bar. The 3D Coordinates of the part can be acquired by applying the Triangulation system. The Laser Probe is normally mounted on the End Effector of a Robotic Arm. For our situation it was called FARO Arm.

FARO's grouping of transportable direction measuring machines (CMMs) comprise of measuring arms, laser trackers, 3D laser scanners and 3D imagers. These convenient CMMs can be utilized for both contact and non-contact estimation. The FARO Arm is a productive Coordinate Measuring Machine (CMM) that permits creator simple substantiation of antique quality by performing 3D evaluation, instrument affirmations, CAD estimation, dimensional examination, figuring out, and so forth. The ScanArm, notwithstanding the FARO Laser Line Probe of the FaroArm put in supreme non-contact 3D examining limit for exhaustive estimation of surface structure, making the ScanArm the perfect amalgamation of a contact and non-contact versatile CMM.

Fig 3.2 FARO Arm

4. RE-DESIGN AND DEVELOPMENT OF BIKE SEAT

4.1 Re-Design of Seat

After doing the statistical analysis of the survey data using SPSS software and looking through the various graphs we found some parts of Yamaha R-15 and some parts of Pulsar were better among all. So we combined them to form a novel seat design.

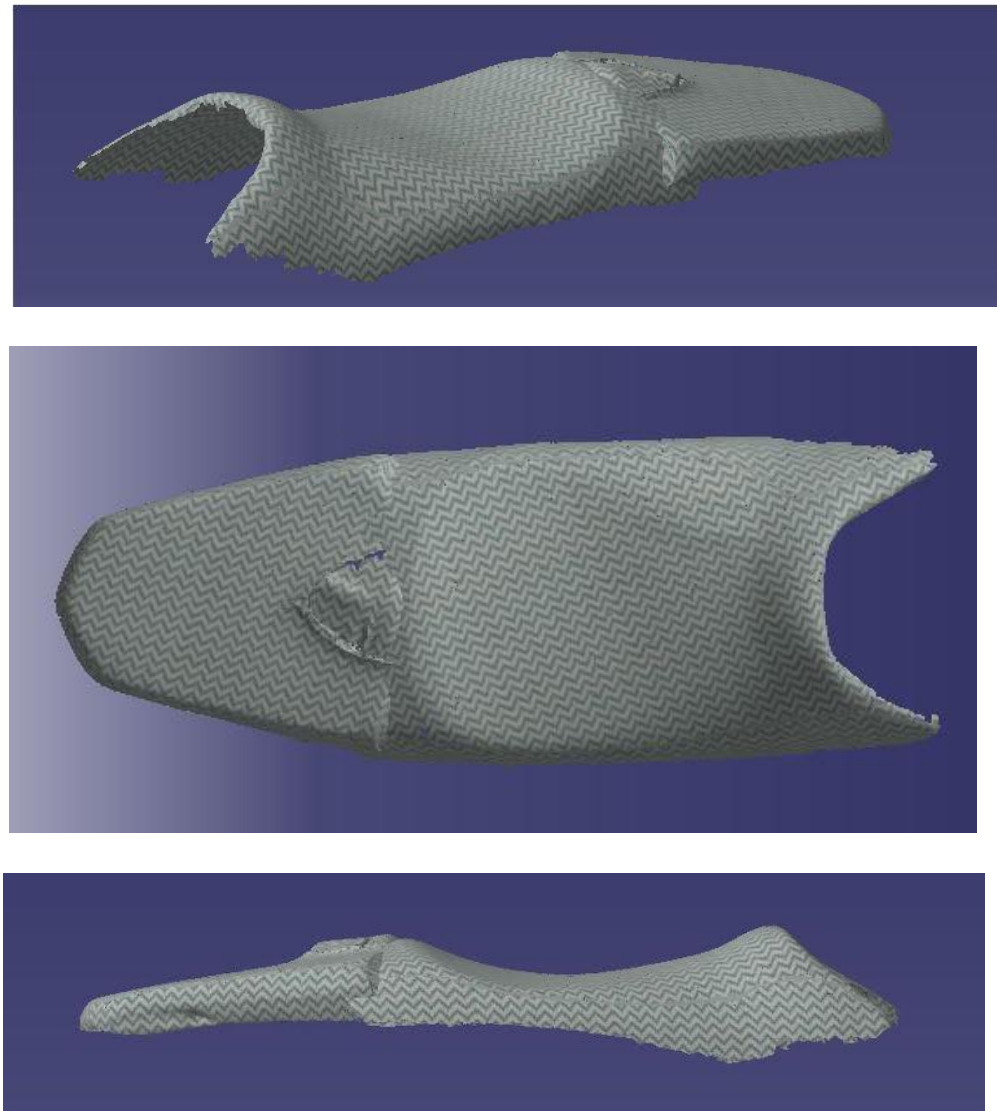


Fig 4.1 New Designed Seat

4.2 Prototype Development

After designing new seat, prototype was made using thermocol.

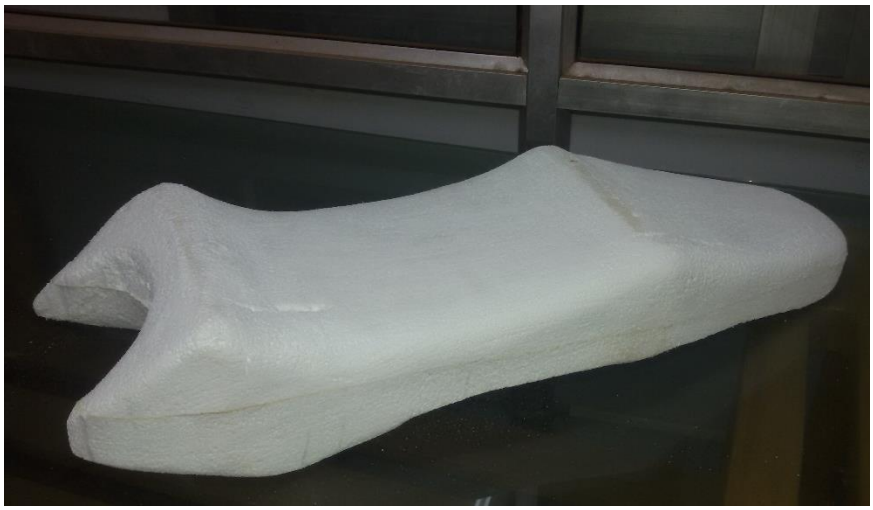


Fig 4.2 Prototype

4.3 Subjective Assessment of New Seat

The new prototype which was formed was tested by the user. Again user were selected for answer the survey question. The question were selected so as to test the comfort level of the bike user by dividing the seat into various parts .Questions were to test the comfort level of each part.

SURVEY FOR BIKE SEAT DESIGN

Personal Detail:

NAME:-_____ AGE: - _____

GENDER:-_____ HEIGHT:-_____

WEIGHT:-_____ Ph. No.:-_____

EMAIL ID:-_____

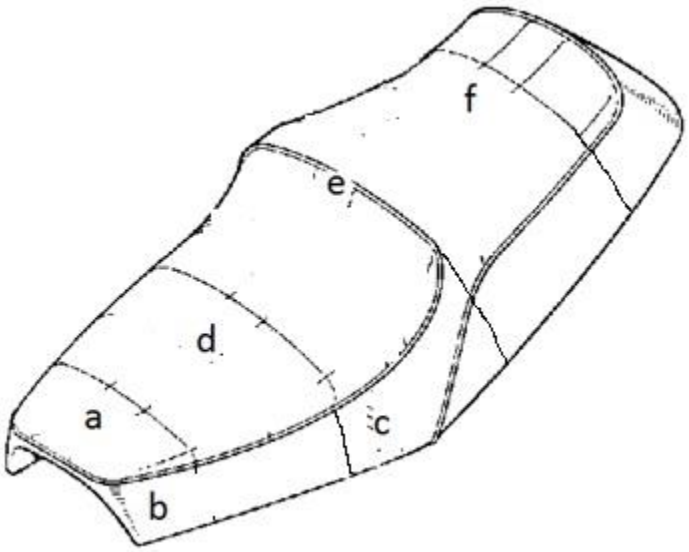
For how many years you are driving? _____

Rate the below question from 1 to 5 for this bike:

1 2 3 4 5

Very discomfort Discomfort Neutral Comfort Very comfort

Considering roughly at different parts of the seat as shown below, rate the comfort zone of various parts –



	1	2	3	4	5
1. Comfort level of part ‘a’?	__	__	__	__	__
2. Comfort level of part ‘b’?	__	__	__	__	__
3. Comfort level of part ‘c’?	__	__	__	__	__
4. Comfort level of part ‘d’?	__	__	__	__	__
5. Comfort level of part ‘e’?	__	__	__	__	__
6. Comfort level of part ‘f’?	__	__	__	__	__

4.3.1 Data Collection and statistical analysis

The survey papers from the individuals were assembled and collaborated into an Excel sheet. The questionnaire was drafted into excel sheet and the analysis of the data was done by the IBM – SPSS software.

Firstly the data of the various comfort level of the body parts were inputted into the SPSS software. The criteria is the various factors that affect the comfort level of the user such as length

width height curvature etc. of bike seat. All criteria are listed in the fig 4.3. The datasheet is as shown in the figure 4.4.

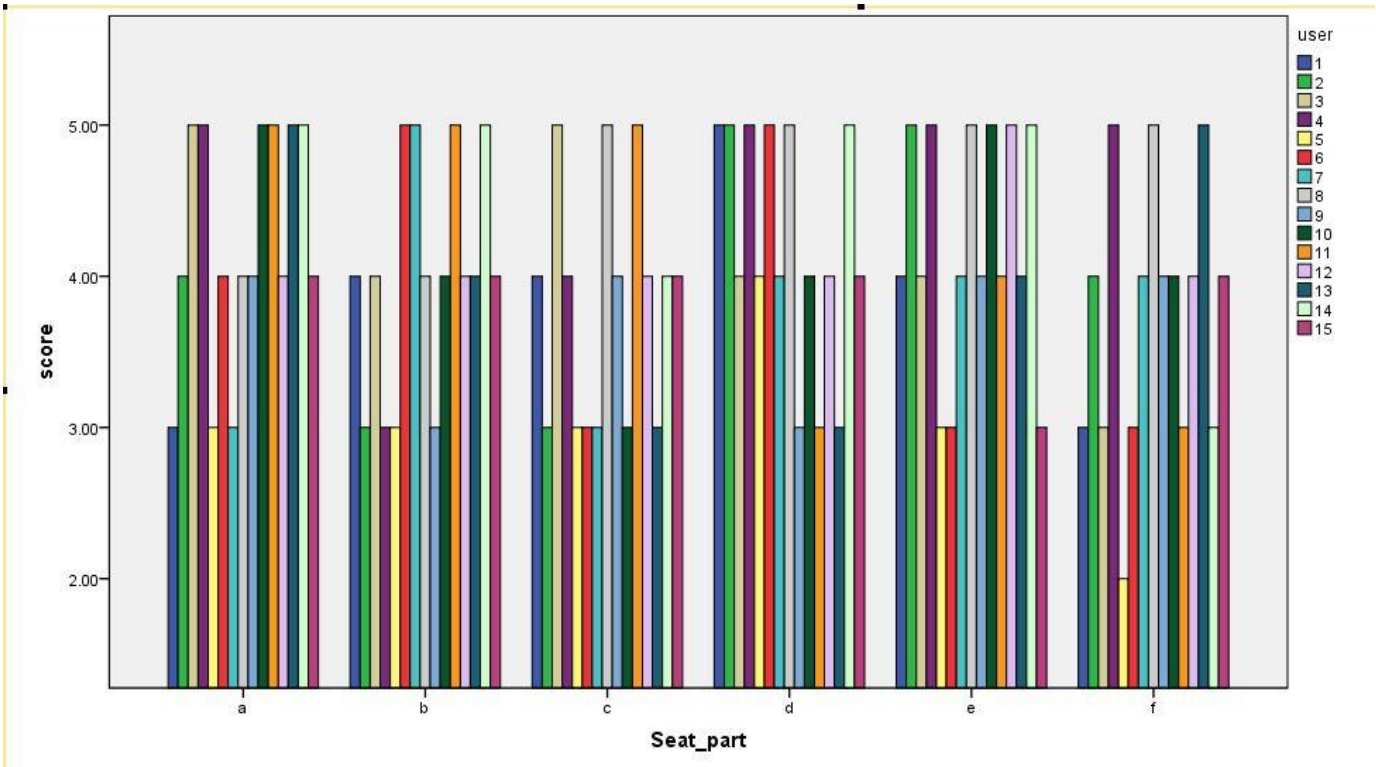


Fig 4.3 Bar chart representing the rating of the bike seat part for the body parts

	Seat_part	user	score
1	1	1.00	3.00
2	2	1.00	4.00
3	3	1.00	4.00
4	4	1.00	5.00
5	5	1.00	4.00
6	6	1.00	3.00
7	1	2.00	4.00
8	2	2.00	3.00
9	3	2.00	3.00
10	4	2.00	5.00
11	5	2.00	5.00
12	6	2.00	4.00
13	1	3.00	5.00
14	2	3.00	4.00
15	3	3.00	5.00
16	4	3.00	4.00
17	5	3.00	4.00
18	6	3.00	3.00
19	1	4.00	5.00
20	2	4.00	3.00
21	3	4.00	4.00
22	4	4.00	5.00
23	5	4.00	5.00

	Seat_part	user	score
24	6	4.00	5.00
25	1	5.00	3.00
26	2	5.00	3.00
27	3	5.00	3.00
28	4	5.00	4.00
29	5	5.00	3.00
30	6	5.00	2.00
31	1	6.00	4.00
32	2	6.00	5.00
33	3	6.00	3.00
34	4	6.00	5.00
35	5	6.00	3.00
36	6	6.00	3.00
37	1	7.00	3.00
38	2	7.00	5.00
39	3	7.00	3.00
40	4	7.00	4.00
41	5	7.00	4.00
42	6	7.00	4.00
43	1	8.00	4.00
44	2	8.00	4.00
45	3	8.00	5.00
46	4	8.00	5.00

	Seat_part	user	score
47	5	8.00	5.00
48	6	8.00	5.00
49	1	9.00	4.00
50	2	9.00	3.00
51	3	9.00	4.00
52	4	9.00	3.00
53	5	9.00	4.00
54	6	9.00	4.00
55	1	10.00	5.00
56	2	10.00	4.00
57	3	10.00	3.00
58	4	10.00	4.00
59	5	10.00	5.00
60	6	10.00	4.00
61	1	11.00	5.00
62	2	11.00	5.00
63	3	11.00	5.00
64	4	11.00	3.00
65	5	11.00	4.00
66	6	11.00	3.00
67	1	12.00	4.00
68	2	12.00	4.00
69	3	12.00	4.00

	Seat_part	user	score
70	4	12.00	4.00
71	5	12.00	5.00
72	6	12.00	4.00
73	1	13.00	5.00
74	2	13.00	4.00
75	3	13.00	3.00
76	4	13.00	3.00
77	5	13.00	4.00
78	6	13.00	5.00
79	1	14.00	5.00
80	2	14.00	5.00
81	3	14.00	4.00
82	4	14.00	5.00
83	5	14.00	5.00
84	6	14.00	3.00
85	1	15.00	4.00
86	2	15.00	4.00
87	3	15.00	4.00
88	4	15.00	4.00
89	5	15.00	3.00
90	6	15.00	4.00

Fig 4.4 Data Sheet representing the rating of the bike seat part for the body parts

5. CONCLUSION AND SCOPE OF FUTURE WORK

By looking at the result from subjective assessment of the new seat designed and the comparison among the existing seats and the new one it can be concluded that new seat designed is better than the existing seats.

Below shown is the bar graph representing the overall rating comparison among the existing seats and the new one.

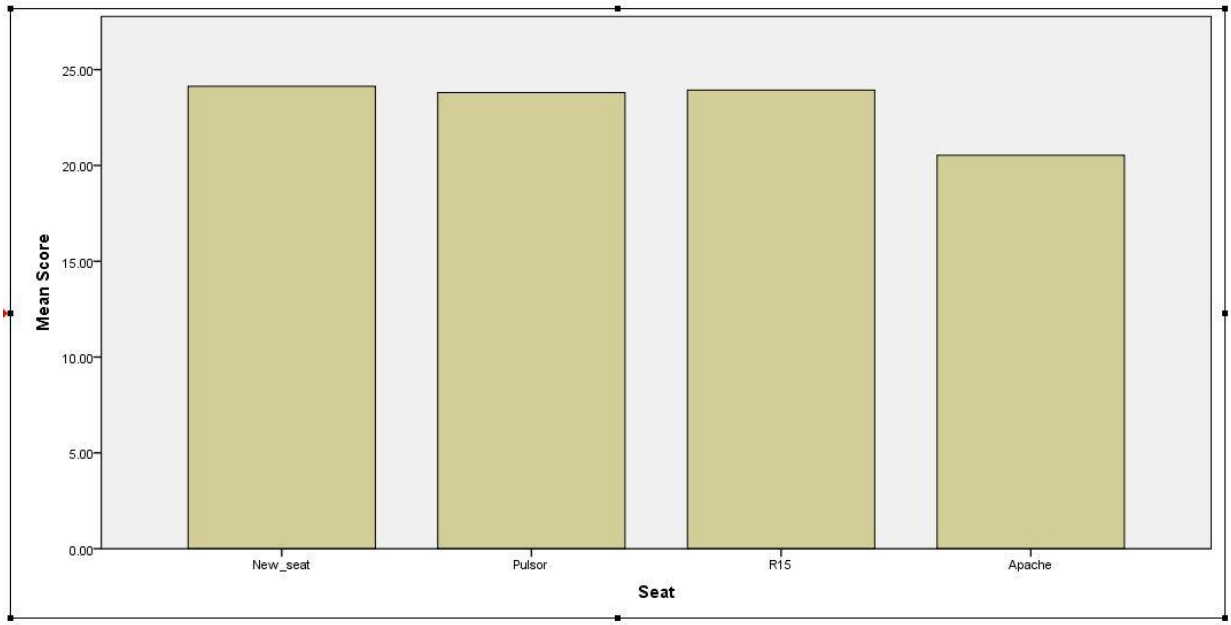


Fig 5.1 Bar graph representing overall rating comparison among all the seats.

Scope of the work:

- Further objective analysis can be done of the existing bikes and the new one using pressure mats and other instruments.
- Prototype of the new seat can be made using the original material and can be tested by actually fitting it in a motor bike.

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